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U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

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**TRANSMITTAL LETTER TO THE UNITED STATES
DESIGNATED/ELECTED OFFICE (DO/EO/US)
CONCERNING A FILING UNDER 35 U.S.C. 371**

(U.S. APPLICATION NO. (If known,

(see 37 C.F.R. 1.5)

09/446769

INTERNATIONAL APPLICATION NO.

PCT/JP99/02243

INTERNATIONAL FILING DATE

27 APRIL 1999

[EARLIEST] PRIORITY DATE CLAIMED

27 APRIL 1998

TITLE OF INVENTION

**DATA STORAGE AND RETRIEVAL APPARATUS AND METHOD OF
THE SAME**

APPLICANTS FOR DO/EO/US

Kazue NAKAMURA

Applicants herewith submit to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. ☒ This express request to begin national examination procedures (35 U.S.C. 371(f)) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U.S.C. 371(b) and PCT Articles 22 and 39(1).
4. ☐ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.
5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2))
 - a. ☐ is transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☒ has been transmitted by the International Bureau.
 - c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C. 371(c)(2)), including 8 sheets of formal drawings and a copy of the International Search Report.
7. ☒ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
 - a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau).
 - b. ☐ have been transmitted by the International Bureau.
 - c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
 - d. ☒ have not been made and will not be made.
8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. ☐ An oath or declaration of the inventors (35 U.S.C. 371(c)(4)).
10. ☐ The annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. ☐ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. ☒ A FIRST preliminary amendment.
☐ A SECOND or SUBSEQUENT preliminary amendment.
14. ☐ A substitute specification.
15. ☐ A change of power of attorney and/or address letter.
16. ☒ Other items or information:

PCT/ISA/210

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17. ☒ The following fees are submitted:

(CALCULATIONS /PTO USE ONLY)

Basic National Fee (37 CFR 1.492(a)(1)-(5):

Search Report has been prepared by the EPO or JPO.....\$840.00(\$840.00

International preliminary examination fee paid to USPTO (37 CFR 1.482) (.....\$700.00

No international preliminary examination fee paid to USPTO (37 CFR 1.482) (but international search fee paid to USPTO (37 CFR 1.445(a)(2))...\$770.00(

Neither international preliminary examination fee (37 CFR 1.482) nor (international search fee (37CFR 1.445(a)(2) paid to USPTO.....\$1040.00 (

International preliminary examination fee paid to USPTO (37 CFR 1.482) (and all claims satisfied provisions of PCT Article 33(2)-(4).....\$96.00 (

ENTER APPROPRIATE BASIC FEE AMOUNT = (\$840.00 /

Surcharge of **\$130.00** for furnishing the oath or declaration later than ☐20 ☐30 (\$000.00 /
months from the earliest claimed priority date (37 CFR 1.492(e)).

17 Claims /Number Filed / Number Extra /Rate (

Total Claims / 17 - 20 = / 0 /X \$18.00 (\$000.00 /

Independent Claims / 2 - 3 = / 0 /X \$78.00 (\$000.00 /

Multiple dependent claim(s) (if applicable) /+ \$260.00 (\$ /

TOTAL OF ABOVE CALCULATIONS = (\$840.00 /

Reduction by 1/2 for filing by small entity, if applicable. Verified Small Entity (/
statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28). (/

SUBTOTAL = (\$840.00 /

Processing fee of **\$130.00** for furnishing the English translation later than (/
☐20 ☐30 months from the earliest claimed priority date (37 CFR 1.492(f)).+ (\$ /

TOTAL NATIONAL FEE = (\$840.00 /

Fee for recording the enclosed assignments (37 CFR 1.21(h)). The assignment (/
must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). \$40.00 per property + (\$ 0.00 /

TOTAL FEES ENCLOSED = (\$840.00 /

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a. ☒ Our check in the amount of **\$840.00** to cover the above fees is enclosed.

b. ☐ Please charge my Deposit Account No. 50-0320 in the amount of \$_____ to cover the above fees.

A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 50-0320. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

**WILLIAM S. FROMMER
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745 FIFTH AVENUE
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SIGNATURE

DENNIS M. SMID
NAME

Dated: DECEMBER 23, 1999

34,930
REGISTRATION NUMBER

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s) : Kazue NAKAMURA
Int'l Appln. No. : PCT/JP99/02243
Int'l Filing Date : 27 APRIL 1999
Title of Invention : DATA STORAGE AND RETRIEVAL
APPARATUS AND METHOD OF THE SAME

745 Fifth Avenue
New York, NY 10151
December 23, 1999

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PRELIMINARY AMENDMENT

Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Before the issuance of the first Official Action, please amend the above-identified application as follows:

IN THE CLAIMS:

Claim 12, line 2, change "8" to --10--.

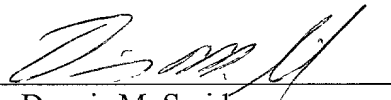
REMARKS

Entry of this Amendment and an early examination on the merits are respectfully solicited.

Please charge any additional fees required for this amendment or credit any overpayment to Deposit Account No. 50-0320.

Respectfully submitted,

FROMMER LAWRENCE & HAUG LLP
Attorneys for Applicant

By: 
Dennis M. Smid
Reg. No. 34,930
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Attorney Docket No. 450118-4848

New Patent Application filed **December 23, 1999**, entitled:

DATA STORAGE AND RETRIEVAL APPARATUS

AND METHOD OF THE SAME

corresponding to PCT Application No. PCT/JP99/02243

filed April 27, 1999

Express Mail No.: EL295739996US

Date of Deposit: December 23, 1999

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8/PRT

09/446769

430 Rec'd PCT/PTO 23 DEC 1999

- 1 -

DESCRIPTION

DATA STORAGE AND RETRIEVAL APPARATUS AND

METHOD OF THE SAME

5

TECHNICAL FIELD

10 The present invention relates to a data storage and retrieval apparatus for recording, storing, and reproducing files in a computer or other data processor and to a method for the same.

BACKGROUND ART

15 Computers and other data processors often use huge volumes of data to achieve desired goals. Ordinarily, this data is classified according to application, type, etc. and the groups of classified data are managed in the form of data files. The data files are stored on hard disks, magneto optic disks (MO), magnetic tape, or other data storage media. When
20 required by the computer or other data processor, the desired data files are read from the data storage medium and used by the applications etc.

25 Up until now, various types of data storage media and systems for managing these data storage media have been proposed and commercialized. For example, the

data storage system using DTF (digital tape format) standard tape proposed by the assignee is one example. In this DTF tape format, the file size, position information, etc. are recorded at the header part of the tape and the last part of the data stored on the tape to enable high speed file access.

As a system to which the DTF standard is applied, there is PetaServe (name of software offered by assignee, registered trademark). PetaServe is a hierarchical storage management (HSM) software which arranges storage systems in a hierarchy according to the properties of the storage media or data storage capacities so as to enable rational management of large-scale storage systems while improving ease of use as seen from the user's standpoint. PetaServe manages storage systems automatically based on user settings in accordance with the properties of the data storage media, such as hard disks, magneto optic disks (MO), and magnetic tape, and the state of use of the data.

PetaServe for example moves files present on a computer hard disk to a more economical removable medium (DTF tape, magnetic tape, or other storage medium) to secure a large apparent storage capacity of the hard disk. Further, when a need arises for use of

a file moved to the removable medium, the file moved
to the removable medium is again restored to the
computer hard disk. In PetaServe, files on the hard
disk are copied to a removable medium and the original
5 files on the hard disk are compressed. This is called
"migration". The restoration of migrated files on to
the hard disk is called "reloading".

Figure 7 is a conceptual view of migration and
reloading. In Fig. 7, reference numeral 10 represents
10 a computer containing a CPU (central processing unit)
11, memory 12, and hard disk 13 and 20 represents a
storage medium comprised of a removable medium.
Reference numerals 30 and 40 show the flow of data at
the time of migration and reloading. Due to the
15 migration, a file 14 on the hard disk 13 is copied to
the removable medium 20, just the information relating
to the migrated file is left in the original file, and
the rest of the content is discarded. Due to this, a
file 14a having the same content as the file 14 stored
20 on the hard disk 13 is stored in the storage medium 20
and the region storing the file 14 on the hard disk 13
can be opened up to other applications. When the CPU
11 etc. desires to use the content of the file 14, it
performs reloading to copy the content of the file 14a
25 from the storage medium 20 to the hard disk 13 and

restore the file 15 on the hard disk 13 to its original state, so the CPU 11 etc. can access the restored file 14 by normal file access procedures.

The migration and reloading are performed automatically by PetaServe, so the user does not have to take particular note of it and through processing can be realized.

In the above reloading, however, when restoring a file 14a migrated to the removable medium 20 on to the hard disk 13 of the computer, the content of the file 14a is read from the removable medium 20 and written on the hard disk 13 of the computer 10. Next, the CPU 11 reads the content of the file 14 from the hard disk 13 and stores it in an assigned region of the memory 12. Since the hard disk 13 is interposed in this reloading, the free space of the hard disk 13 is used up and the speed of access to the file 13 as seen from the CPU 11 is limited by the write and read speed of the hard disk so there is the disadvantage that the system performance ends up falling.

Therefore, the present invention was made in consideration of the above problem of the system of the related art and has as its object the provision of a data storage and retrieval apparatus, and a method for the same, which directly writes data read out from

a file stored in a removable medium or other storage medium in a region assigned in a memory of a computer or the like without going through a hard disk when there is a request for access to a migrated file (in an embodiment of the present invention, this being referred to as DDA (direct device access)) and thereby enables the realization of high speed file access without using up the space on the hard disk and without being dependent on the access speed of the hard disk.

DISCLOSURE OF THE INVENTION

The data storage and retrieval apparatus of the present invention is one having a data processor, including a memory, central processing unit, and first storage medium, which performs migration for transferring a file stored in the first storage medium to a second storage medium provided outside of the data processor and then generates an information file including access information for the file in the first storage medium, comprising an information acquisition means for reading said access information from the information file stored in the first storage medium when the data processor accesses a migrated file, a file opening means for opening the transferred file in the second storage medium based on the access

information acquired from the data acquisition means,
and a reading means for reading the stored data from
the opened file and writing it in a predetermined
region on the memory of the data processor.

5 Further, in the present invention, preferably the
data processor is a computer, the first storage medium
is a hard disk, and the second storage medium is a
removable medium.

10 Further, in the present invention, preferably the
data processor determines a priority of migration
based on a predetermined standard for a plurality of
files stored on the first storage medium and performs
the migration from the file with the highest priority;
a file stored on the first storage medium has an
15 information region for storing file management
information and a data region for storing data; all of
the data of the data region is transferred to the
second storage medium by the migration; and an
information file is generated on the first storage
20 medium.

 Further, in the present invention, preferably,
the information file contains the file management
information, access information to the file
transferred to the second storage medium, and size
25 information of the file on the first storage medium

before the migration, and the data region of the file on the first storage medium is opened up after the information file is generated.

Further, the data storage and retrieval method of the present invention is a data storage and retrieval method where a data processor, including a memory, central processing unit, and first storage medium, performs migration for transferring a file stored in the first storage medium to a second storage medium provided outside of the data processor, then generates an information file including access information to the first storage medium, comprising reading said access information from the information file stored in the first storage medium when the data processor accesses a migrated file, opening the transferred file in the second storage medium based on the read access information, reading the stored data from the opened file, and storing it in a predetermined region on the memory of the data processor.

BRIEF DESCRIPTION OF THE DRAWINGS

The above object and features of the present invention will become clearer from the following description given with reference to the attached drawings, in which:

Fig. 1 is a block diagram of an embodiment of a

data storage and retrieval apparatus of the present invention and shows the configuration of the data storage and retrieval apparatus and the flow of the data at the time of migration and DDA;

5 Fig. 2A is a view of the configuration of an ordinary file in the present embodiment;

 Fig. 2B is a view of the configuration of a bit file in the present embodiment;

10 Fig. 2C is a view of the configuration of a stub file in the present embodiment;

 Fig. 3 is a view of the flow of the migration and DDA;

 Fig. 4 is a flow chart of the processing routine for opening a file in the DDA;

15 Fig. 5 is a flow chart of the processing routine for reading data in the DDA;

 Fig. 6 is a flow chart of the processing routine for closing a file in the DDA; and

20 Fig. 7 is a view of the configuration of a data storage and retrieval apparatus and flow of data at the time of migration and reloading of the related art.

BEST MODE FOR WORKING THE INVENTION

25 An embodiment of the data storage and retrieval apparatus of the present invention will be explained

next with reference to the block diagram of Fig. 1.

The data storage and retrieval apparatus of this embodiment is provided with a data processor including a CPU 11, memory 12, and hard disk 13, for example, a computer 10, and a data storage medium 20 provided outside the computer 10. The data storage medium 20 is for example comprised by a DTF tape, magnetic tape, or other removable medium.

In the data storage and retrieval apparatus of the present embodiment, the CPU 11 operates based on a control program and controls the memory 12, hard disk 13, and other peripherals. The data storage and retrieval apparatus automatically manages the files on the hard disk 13, based on parameters set by the user, according to the properties of the storage media and the state of use of the data, for example, the frequency of use, the time elapsed until use from storage, the transfer and search speed, etc. so as to realize the maximum storage and operational efficiency. For example, it determines the priority of migration based on predetermined conditions such as the frequency of use in the plurality of files stored on the hard disk 13. Further, it performs migration from the file with the highest priority, for example, the file with the lowest frequency of use. Here, as

shown in Fig. 1, it designates the file 14 for the hard disk 13 as the file for migration and performs migration for transferring the file 14 from the hard disk 13 to the external storage medium 20.

5 The migration in the data storage and retrieval apparatus of the present embodiment is the same as the migration in the above-mentioned PetaServe. First, the content of the file 14 covered by the migration is copied to the external storage medium 20. Due to this,
10 a file 14a of the same content as the file 14 is produced in the external storage medium 20. Further, a stub file storing the access information of the file 14 etc. is produced in the hard disk 13. The stub file stores the access information of the file 14, for
15 example, the bit file ID, file size, etc. and does not hold actual content, so the size becomes far smaller than that of the original file 14. Therefore, the region of storage of the original file 14 in the hard disk 13 is opened up to other applications and the
20 usable size of the hard disk 13 is expanded.

 Figures 2A to 2C show the concepts of the original file, bit file, and stub file stored on the hard disk 13.

 As shown in Fig. 2A, a file stored on the hard
25 disk is comprised of a header region comprised of an

i-node and a user data region storing the user data.
The i-node is formed in byte units, is managed by a
file management system, and holds the information
required for a file. In the user data region, the user
5 data is stored divided into block units (for example,
512 byte units).

As shown in Fig. 2B, a bit file is comprised of
the user data region of the migrated original file and
a bit file ID. Note that the bit file ID is an
10 unambiguous ID in the system prepared at the time of
migration. The bit file is linked with the stub file
by this bit file ID.

As shown in Fig. 2C, a stub file is comprised of
the i-node, the first block of the user data region,
15 the bit file ID, the logical size of the file before
migration (in both byte and block units), and the stub
file ID. The size of the stub file is fixed and is for
example set to 1023 bytes.

Due to the migration, a bit file is formed in the
20 external storage medium and only the stub file remains
at the hard disk. The user can search through and
restore migrated files for access through the stub
files remaining on the hard disk. That is, even when a
file is migrated, it appears to the user that the
25 original file remains on the hard disk.

The data storage and retrieval apparatus of the present embodiment controls the migration and DDA of the files by an MFS (migrating file system). Note that the MFS spoken of here is comprised of a processor and a control program loaded in the processor. Further, a client in which the function of the MFS is installed is called an MFS client.

Figure 2 is a view of the migration and DDA operation. In Fig. 3, 100 is an MFS client, 110 a data mover (dm), 120 a bit file server (bfsc), 130 a storage server (stsd), 140 a removable media server (RMS), 150 a removable media, and 160 a storage data base. As shown, the removable media server 140 includes a volume server 142 and a library server 144.

The MFS client 100 issues a migration or DDA request and outputs it to the data mover 110 and the bit file server 120. Further, the MFS client 100 provides a TCP stream socket port (data input-output interface) number used for movement of data to the data mover 110 and the bit file server 120.

The bit file server 120 receives the request for migration and DDA from the MFS client 100 and assigns a bit file ID to it. Further, it selects a storage server 130 and a volume server 142 in the removable media server 140. The bit file server 120 manages the

arrangement and information (migration path etc.) of all of the bit files stored in the removable media 150 through the storage data base and outputs the necessary instructions to the storage server 130.

5 The storage server 130 determines how to store the designated bit file. It determines a suitable volume set for the processing for storage of the bit file requested. Here, the "volume" is one unit of a physical storage unit. For example, in the case of a
10 tape unit, it is one tape. In the case of a unit not allowing simultaneous access of all surfaces (for example, an optical disk unit), it is one surface. "Volume set" means a set of the same type of media. The storage server 130 outputs a request for mounting
15 of a volume or mounting of a disk to the removable storage server 140 or starts up the data mover 110.

 The data mover 110 uses the STC stream socket port provided by the MFS client 100 to execute the actual data move from the MFS client 100 to the
20 removable media 150 (or the reverse). When the volume for which movement of data was requested is mounted, the storage server 130 receives the mount information from the removable media server 140 and the data mover 110 is started up.

25 The removable media server 140 manages all of the

volumes in the removable media 150 and makes requests for mounting or unmounting suitable volumes. Further, the removable media server 140 assigns and opens up volumes to the client and reserves and frees volumes to the client.

The storage data base 160 is a data base (file) managed by the bit file server 120. The information of all of the bit files in the storage is stored in the storage data base 160. The bit file information is updated with every migration or DDA.

Below, an explanation will be made of the flow of migration and DDA in the present embodiment with reference to Fig. 3.

At the time of migration, an instruction signal S100 for performing the migration on a predetermined file on the hard disk is output from the MFS client 100 to the bit file server 120. Further, a TCP stream socket port number S101 used for data movement is output from the MFS client 100 to the data mover 110.

The volume server 142 and storage server 130 are selected by the bit file server 120. Further, the volume server and volume to be used are determined based on the information provided from the MFS client 100, in particular the migration path assigned to the stored file, the size of the file, and other

information. The storage data base 160 is updated by the bit file server 120. Here, when the bit file server 120 is called up by the storage server 130, it assigns a bit file ID to the new bit file which is added to a bit file table in the storage data base 160. Further, the state of use of the selected volume is stored in the storage data base 160. A signal 120 showing the ID of the bit file migrated is returned by the bit file server 120 to the MFS client 100.

Next, a mount request S130 for mounting the selected volume is output from the storage server 130 to the volume server 142 in the removable media server 140. Therefore, the storage server 130 is connected to the volume server 142.

When the selected volume has already been mounted, a signal S140 showing that state is output from the volume server 142 to the storage server 130. The storage server 130 outputs a startup signal S132 to the data mover 110 when it receives information that the selected volume has been mounted from the volume server 142. Further, information such as the socket number of the client, the bit file ID, and the mount point is supplied by the storage server 130 to the data mover 110.

The data mover 110 produces a file in the

selected volume, connects to the MFS client 100, and moves the data. The MFS client 100 reads out the data from the file on the hard disk and writes it to the socket port. The data mover 110 reads out the data
5 from the socket port and writes its in the file produced in the volume.

Due to the operation explained above, the file on the hard disk of the MFS client 100 is migrated and a bit file is formed in the selected volume. A stub file
10 is stored on the hard disk of the MFS client 100 and the data region of the original file is opened up.

The DDA is the reverse to the migration. In the DDA of the present embodiment, the content of a designated bit file is directly stored in a memory
15 region assigned for the application in the client without going through the hard disk of the MFS client 100. Figures 4 to 6 are flow charts of the flow of the file open, data read, and file close routines at the time of DDA. This DDA will be explained in detail
20 below with reference to these flow charts.

The DDA is executed when a request for access to a stub file is issued by an application. For example, when reading the data portion of a file of more than 512 byte size, DDA is executed when there is a write
25 operation in the file or when there is a change in the

size of the file. In this case, a predetermined region of the memory is assigned by the application requesting the access to the stub file and the data read from the accessed file is stored in that assigned region.

Figure 4 is a flow chart of the file open routine. In the MFS client 100, a file open routine starts along with a file open command "dda_open(path, oflag, mode)" from an application etc. Due to this processing, in accordance with a file open command, the bit file descriptor of the file having the path name designated by "path" is opened in accordance with the open flag "oflag". Note that, in Fig. 4, "mode" depicts the mode of the file to be opened.

First, as shown in step S1, the file information of "path" is obtained. When the file is a file which does not exist in the designated migrating file system, an error code is set, the value of "-1" is returned, then the processing is ended (step S12).

Next, as shown in step S2, when the existence of the file designated by "path" is confirmed in the designated migrating file system of the host computer 10, the status of the file in the migrating file system is acquired, then whether the file is a stub file or a shadowed file is confirmed. When the status

the file on the MFS cannot be acquired, an error code is set, the value of "-1" is returned, then the processing is ended. Note that here, a "shadowed file" is a file which exists as both a file on the hard disk in the MFS client and a file of the same content migrated to a predetermined volume.

Then, as shown in step S3, the file designated by "path" is opened. Here, when the designated file cannot be opened, the error code is set, the value of "-1" is returned, then the processing is ended.

Next, as shown in step S4, the bit file information is acquired and whether the media family is a magnetic tape of the DTF format is confirmed. When the media family is not a DTF format magnetic tape, an error code is set, the value of "-1" is returned, then the processing is ended.

Next, as shown in step S5, a link with the volume server is established and the descriptor of the file connected to the link is returned. Here, when the volume server cannot be linked with, an error code is set, the value of "-1" is returned, then the processing is ended.

At step S6, a specific volume and empty drive are reserved from the volume server linked with the file descriptor returned in the previous step S5. When

failing to reserve an empty driver, an error code is set, the value of "-1" is returned, then the processing is ended.

5 Next, at step S7, the reserved volume, here, the DTF format magnetic tape, is mounted in the reserved driver. When failing to mount, an error code is set, the value of "-1" is returned, then the processing is ended.

10 After successful mounting of the tape at step S7, as shown in step S8, the volume mounted to the driver is located up to a read position corresponding to the bit file descriptor. Note that, here, when the location to the read position fails, an error code is set, the value of "-1" is returned, then the
15 processing is ended.

 Then, as shown in step S9, exactly the prescribed tape buffer size worth of data is read from the read position corresponding to the bit file descriptor to a tape buffer. When failing in the read operation, in
20 the same way as the steps described above, an error code is set, the value of "-1" is returned, then the processing is ended. The tape buffer is provided for example by the removable media server. The data is read from the tape through the tape buffer. At step
25 S10, header information located at the head of the

tape buffer is acquired. Here, when the header information cannot be acquired, an error code is set, the value of "-1" is returned, then the processing is ended.

5 Finally, when the above series of processing is completely finished normally, as shown in step S11, the file descriptor (fd) opening the file designated by "path" is returned and the processing is ended.

10 The file descriptor of the file designated by "path" is determined by the processing from step S1 to S11. After that, the data is read from the designated file corresponding to the file descriptor.

15 Figure 5 is a flow chart of the operating routine when reading data from a designated file. The file is read by reading n number of bytes worth of data from the bit file corresponding to the bit file descriptor "fd" obtained by the above file open routine to the buffer designated by "buf" (here, this is given as a user buffer). Note that, here, the n number of bytes is made a maximum 1 megabyte. When n is 0, "0" is
20 returned and no result is given.

 Below, an explanation will be made of the file read operation by referring to Fig. 5.

25 First, as shown in step SR1, whether the designated size n bytes of the read operation is below

1 megabyte or not is confirmed. When the result is that the n bytes of the designated size is greater than 1 megabyte, an error code is set, the value of "-1" is returned, then the processing is ended.

5 Next, at step SR2, whether the designated bit file descriptor "fd" is a bit file descriptor obtained by the above file open operation is confirmed. When the bit file descriptor "fd" is not the bit file descriptor obtained by the file open operation, an
10 error code is set, the value of "-1" is returned, then the processing is ended.

 Then, as shown in step SR3, the header part at the head of the tape buffer read in the above file open operation is skipped and the pointer is moved to
15 the head of the actual data. Further, the size of the data to be copied to the user buffer is confirmed. Here, the size of the memory copy is n bytes when the actual data read to the tape buffer is larger than n bytes, while the size of the actual data is set when
20 it is smaller than n bytes. Next, the routine proceeds to the next step SR4.

 At step SR4, whether the bit file corresponding to the bit file descriptor "fd" is a spanned bit file is confirmed. When the bit file is not spanned, the
25 routine proceeds to step SR10, where exactly the data

of the size set at step SR3 is copied to the user buffer, then the routine proceeds to step SR7. Note that here, a "spanned bit file" means a bit file stored divided between two volumes.

5 When it is confirmed at step SR4 that the bit file corresponding to the bit file descriptor "fd" is spanned, the routine proceeds to step SR5, where data of exactly the size set at step SR3 is copied to the user buffer, then, when necessary, the next volume is
10 prepared and data read to the tape buffer. Here, when failing in the processing, an error code is set, the value of "-1" is returned, then the processing is ended.

 When the processing of step SR5 is carried out
15 normally, the routine proceeds to step SR6, where when there is any remaining area uncopied in the user buffer, data of exactly that amount of bytes is copied from the tape buffer to the user buffer.

 As shown in Fig. 5, after either of the
20 processing of step SR6 or step SR10 is carried out, the processing of step SR7 is carried out. At step SR7, when the size of the actual data except the header of the bit file is smaller than the total size of the data copied to the user buffer, that size is
25 returned, then the processing is ended (step SR11).

When the size of the actual data is greater than the total size of the data copied to the user buffer, the routine proceeds to step SR8.

At step SR8, whether there is any data to be
5 copied remaining in the tape buffer is confirmed. When
there is data uncopied in the tape buffer, that is,
there is actual data remaining in the tape buffer,
data of exactly that size is copied to the user
buffer. When is no uncopied data in the tape buffer,
10 the routine goes to step SR9.

At step SR9, the data is read from the volume to
the tape buffer. When failing in this processing, an
error code is set, the value of "-1" is returned, then
the processing is ended. When succeeding in reading to
15 the tape buffer, the routine returns to step SR4 and
the processing is repeated.

When all of the series of processing succeeds, a
non-negative integer indicating the number of bytes of
the actually read data is returned. The number of
20 bytes becomes smaller when the number of bytes
remaining in the bit file is smaller than "n" and
becomes "0" at the end of the file. That is, when "0"
is returned as a result of the data read operation,
the fact that all of the actual data in the file has
25 been read is shown. Along with this, the data read

operation of the magnetic storage and retrieval apparatus ends.

After the end of the data read operation, the file is closed. Figure 6 shows the file close routine.

5 Below, an explanation will be given referring to Fig. 6.

When closing the file, the bit file corresponding to the bit file descriptor designated by "fd" is closed. Note that here "fd" is a bit file descriptor
10 obtained by the above file open operation.

First, as shown in step SC1, whether the designated bit file descriptor "fd" is a bit file descriptor obtained by the above file open operation is confirmed. When the bit file descriptor "fd" is not
15 the bit file descriptor obtained by the file open operation, an error code is set, the value of "-1" is returned, then the processing is ended. Further, the processing of steps SC2 and SC3 is skipped and the processing of step SC4 is executed.

20 On the other hand, when the bit file descriptor "fd" is the bit file descriptor obtained by the file open operation, the routine proceeds to the next step SC2.

At step SC2, the specific volume and empty driver reserved at the file open operation are released.
25

According to this, the reserved volume and the driver are opened up and become available for other processing. Here, when failing in the release of the reserved volume and empty driver, an error code is set, the value of "-1" is returned, then the processing is ended.

After the processing of step SC2 is carried out normally, the routine proceeds to step SC3. At step SC3, the volume server linked in the file opening is released. Here, when failing in the release, an error code is set, the value of "-1" is returned, then the processing is ended.

When succeeding in the release of the linked volume, the routine proceeds to step SC4, where the "path" designated in file open operation is closed. When failing in closing the "path", an error code is set, the value of "-1" is returned, then the processing is ended.

When the closing of the "path" at step SC4 is carried out normally, at the next step SC5, the device (reserved driver) is closed. Here, in the same way as the steps described above, when failing in the closing, an error code is set, the value of "-1" is returned, then the processing is ended.

When the above series of processing is normally

ended, "0" is returned and the processing ended (step SC6), while when not normally ended, "-1" is returned, so whether the file closing has ended normally or not can be judged by the value returned at the file closing by the application.

As explained above, according to the data storage and retrieval apparatus and method of the present invention, when performing processing for DDA of a migrated file, the content of a bit file stored on a storage medium, for example, a magnetic tape, is read out, then directly written into a memory assigned to an application without going through a hard disk. Therefore, it is possible to avoid using up the space of the hard disk and realize high speed file access without depending on the write speed of the hard disk.

CAPABILITY OF UTILIZATION IN INDUSTRY

The data storage and retrieval apparatus and method of the present invention can be applied to a computer, a computer network comprised of a plurality of computers, or particularly a large-size data processing system handling a large amount of data.

CLAIMS

1. A data storage and retrieval apparatus having a data processor, including a memory, central processing unit, and first storage medium, which performs migration for transferring a file stored in the first storage medium to a second storage medium provided outside of the data processor and then generates an information file including access information for the file in the first storage medium, comprising:
- an information acquisition means for reading said access information from the information file stored in the first storage medium when the data processor accesses a migrated file,
- a file opening means for opening the transferred file in the second storage medium based on the access information acquired from the information acquisition means, and
- a reading means for reading the stored data from the opened file and storing it in a predetermined region on the memory of the data processor.
2. A data storage and retrieval apparatus as set forth in claim 1, wherein the data processor is a computer.
3. A data storage and retrieval apparatus as

set forth in claim 1, wherein the first storage medium is a hard disk.

4. A data storage and retrieval apparatus as set forth in claim 1, wherein the second storage
5 medium is a removable medium.

5. A data storage and retrieval apparatus as set forth in claim 1, wherein the data processor determines a priority of migration based on a
predetermined standard for a plurality of files stored
10 on the first storage medium and performs the migration from the file with the highest priority.

6. A data storage and retrieval apparatus as set forth in claim 1, wherein a file stored on the first storage medium has an information region for
15 storing file management information and a data region for storing data; all of the data of the data region is transferred to the second storage medium by the migration; and an information file is generated in the first storage medium.

20 7. A data storage and retrieval apparatus as set forth in claim 1, wherein the information file contains the file management information, access information to the file transferred to the second storage medium, and size information of the file on
25 the first storage medium before the migration.

8. A data storage and retrieval apparatus as set forth in claim 1, wherein the data region of the file on the first storage medium is opened up after the information file is generated.

5 9. A data storage and retrieval apparatus as set forth in claim 6, wherein a file including the transferred file and the access information to the data is formed in the second storage medium by the migration.

10 10. A data storage and retrieval apparatus as set forth in claim 1, wherein the file opening means generates a file descriptor specifying a file transferred to the second storage medium based on the access information.

15 11. A data storage and retrieval apparatus as set forth in claim 10, wherein the reading means reads the content of a file opened by the opening means based on the file descriptor and stores it in a predetermined region of the memory of the data processor.

20 12. A data storage and retrieval apparatus as set forth in claim 8, further comprising a file closing means for closing a file opened by the opening means based on the file descriptor after the data
25 finishes being read.

13. A data storage and retrieval method wherein
a data processor, including a memory, central
processing unit, and first storage medium, performs
migration for transferring a file stored in the first
5 storage medium to a second storage medium provided
outside of the data processor, then generates an
information file including access information to the
first storage medium, comprising steps of:

reading said access information from the
10 information file stored in the first storage medium
when the data processor accesses a migrated file,

opening the transferred file in the second
storage medium based on the read access information,
and

15 reading the stored data from the opened file
and storing it in a predetermined region on the memory
of the data processor.

14. A data storage and retrieval method as set
forth in claim 13, wherein the data processor
20 determines a priority of migration based on a
predetermined standard for a plurality of files stored
on the first storage medium and performs the migration
from the file with the highest priority.

15. A data storage and retrieval method as set
25 forth in claim 13, wherein a file stored in the first

storage medium has an information region for storing
file management information and a data region for
storing data and the migration comprises transferring
the data of the data region to the second storage
5 medium and generating an information file in the first
storage medium.

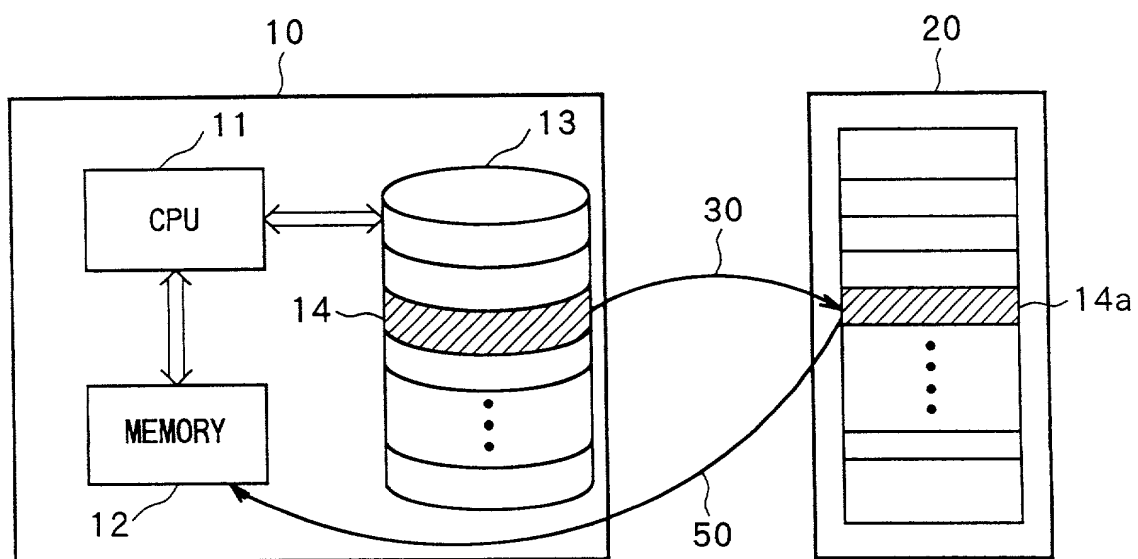
16. A data storage and retrieval method as set
forth in claim 15, further comprising a step of
opening up the data region of the file on the first
10 storage medium after generating the information file.

17. A data storage and retrieval method as set
forth in claim 13, wherein the migration forms a file
containing the transferred data and access information
to the data in the second storage medium.

ABSTRACT

A data processor, including a memory, central processing unit, and first storage medium, for example, a hard disk, performs migration for transferring a file stored in the first storage medium to a second storage medium, for example, a large capacity magnetic tape, provided outside of the data processor and then generates an information file including access information for the file in the first storage medium and opens up the data region of the file. When the data processor accesses a migrated file, an information acquisition means reads said access information from the information file stored in the first storage medium, a file opening means opens the transferred file in the second storage medium based on the access information acquired by the information acquisition means, and a reading means reads the data from the opened file and stores the read data in an assigned memory region of the data processor.

FIG. 1



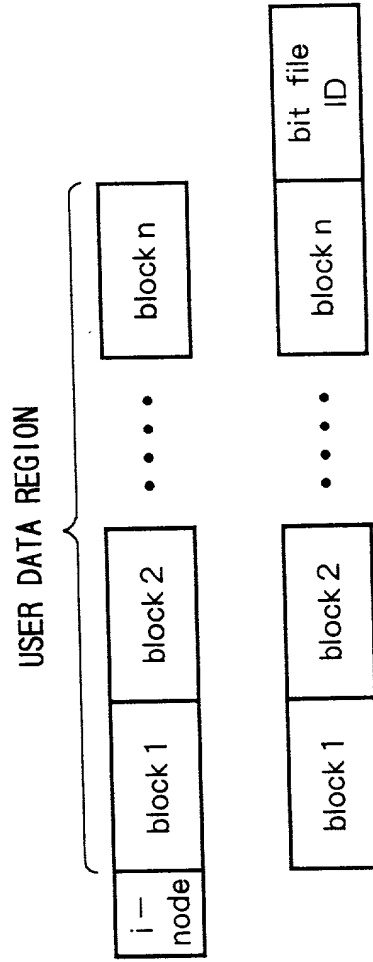


FIG.2A ORIGINAL FILE

FIG.2B BIT FILE

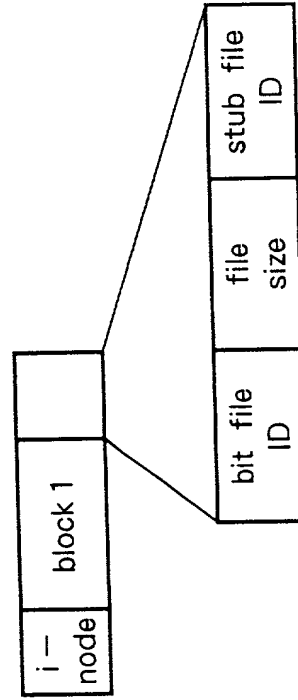


FIG.2C STUB FILE

FIG.3

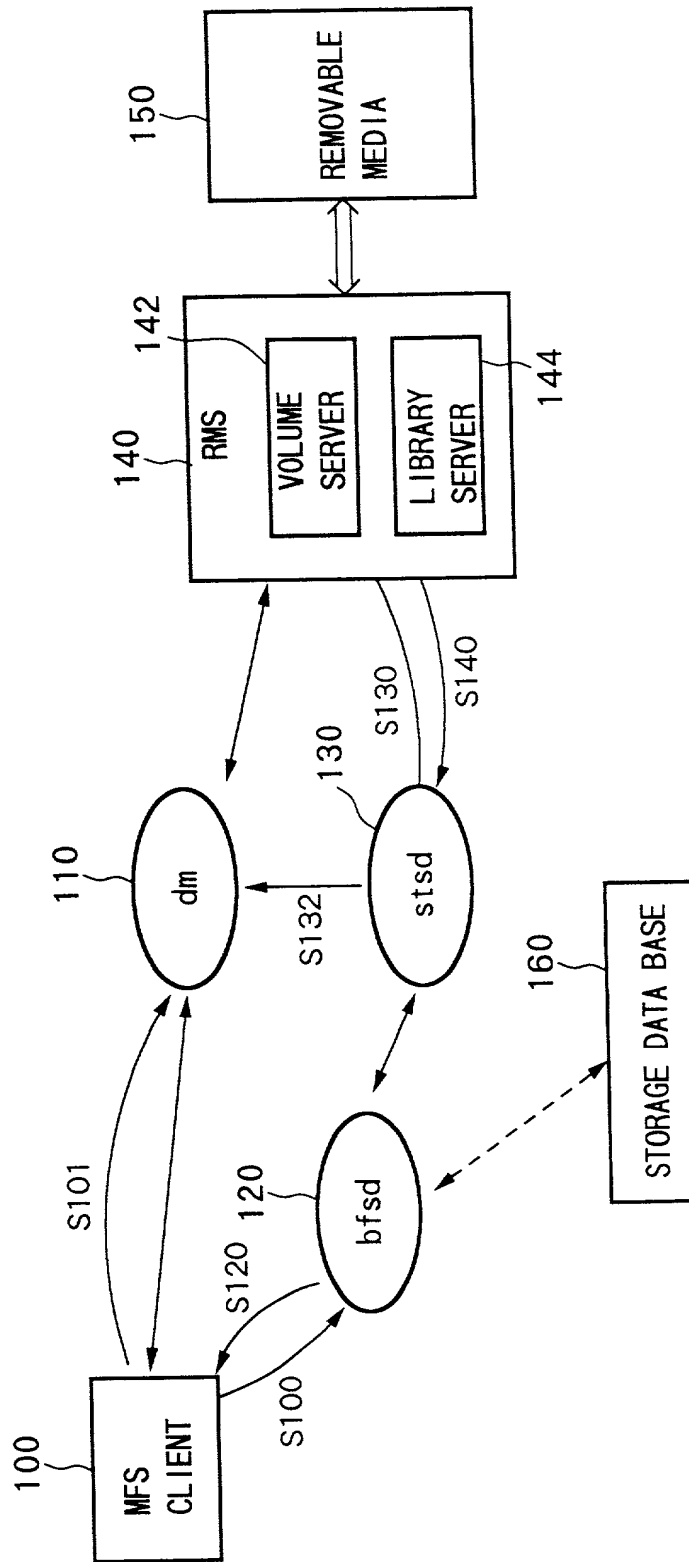


FIG.4

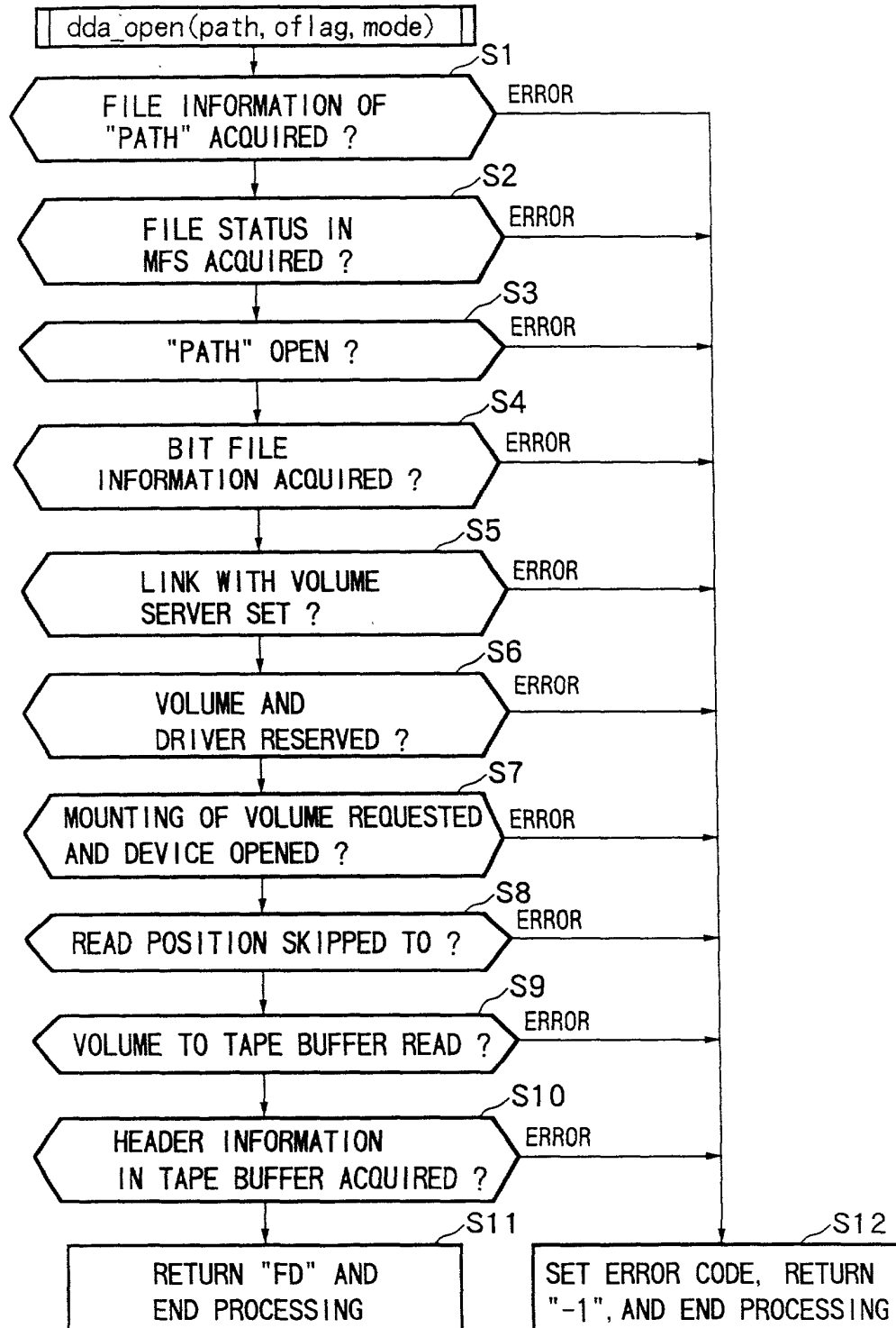


FIG.5

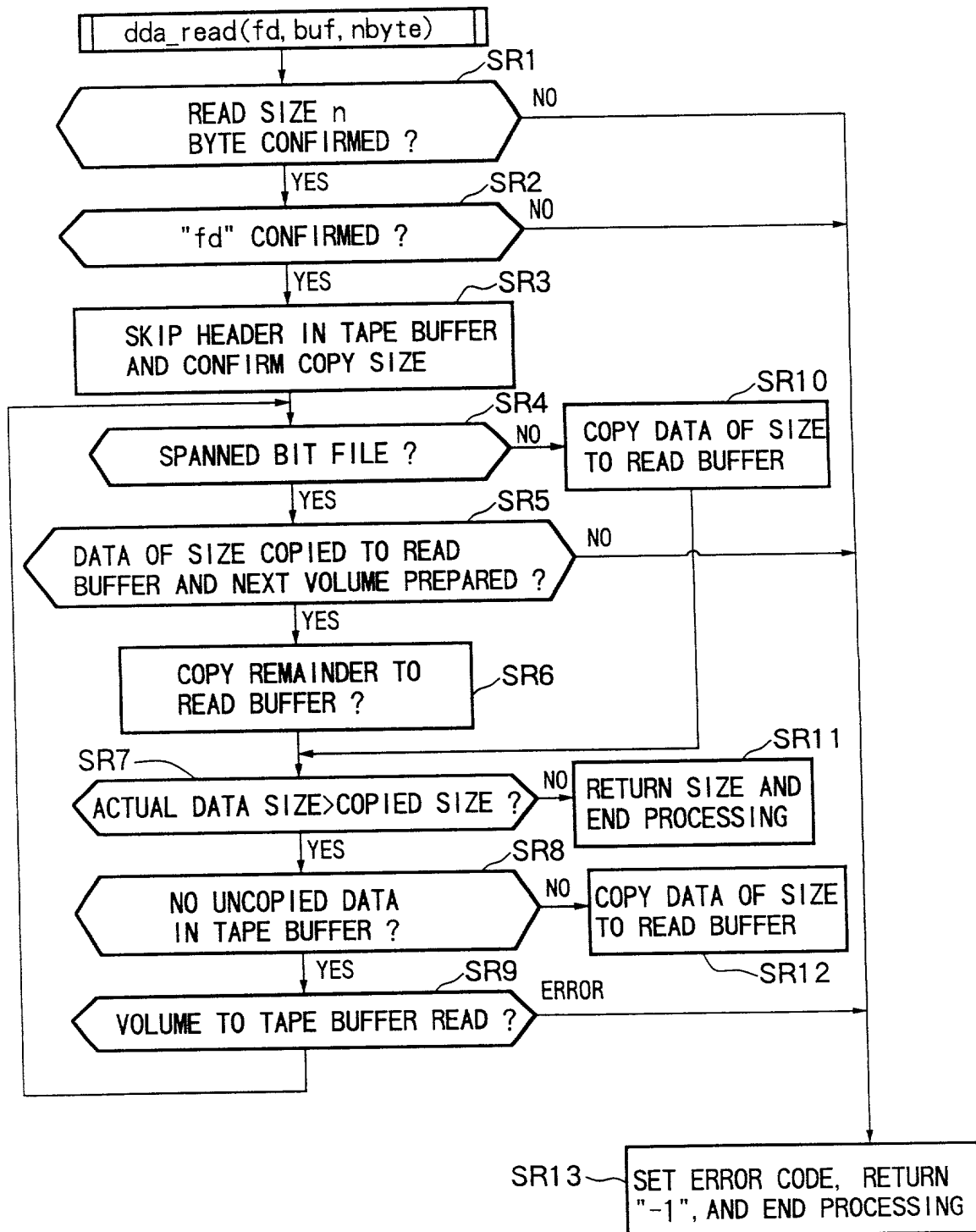


FIG.6

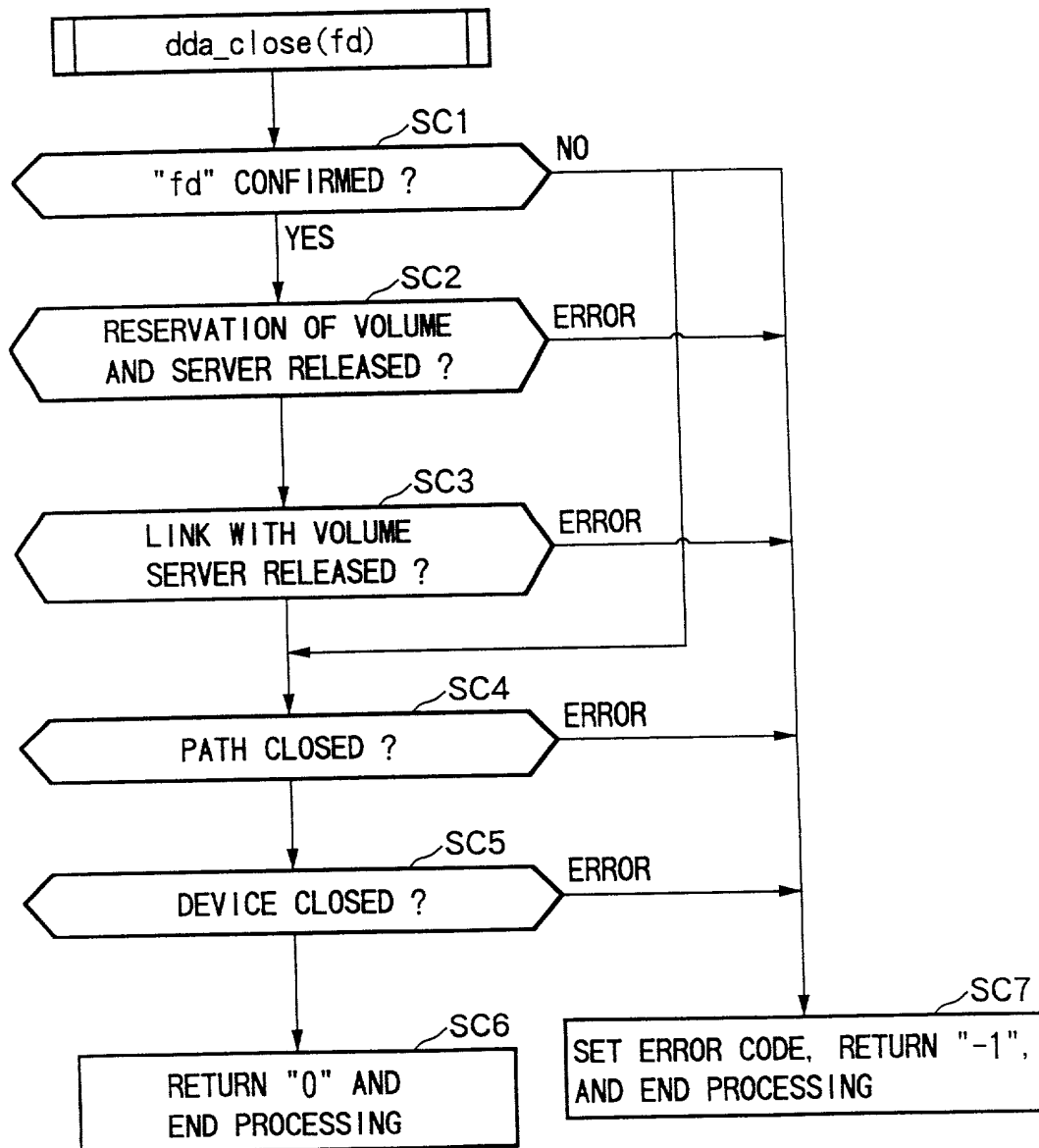
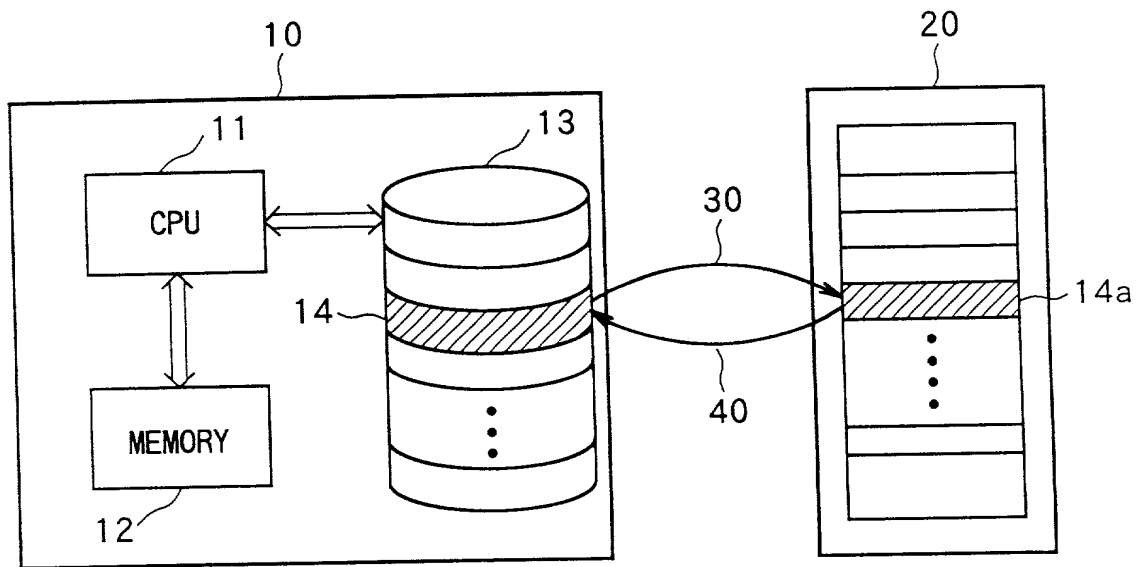


FIG. 7



LIST OF REFERENCES

- 10... computer
 - 11... CPU
 - 12... memory
 - 13... hard disk
 - 14, 14a... files
- 20... storage medium
- 30... flow of data during migration
- 40... flow of data during reloading
- 50... flow of data during DDA
- 100... MFS client
- 110... data mover
- 120... bit file server
- 130... storage server
- 140... removable media server
- 150... removable media
- 160... storage data base

DECLARATION FOR PATENT APPLICATION (JOINT OR SOLE)

(Under 37 CFR § 1.63; with Power of Attorney)

FROMMER LAWRENCE & HAUG LLP

FLH File No. 450118-4848

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name,

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention ENTITLED:

DATA STORAGE AND RETRIEVAL APPARATUS AND METHOD OF THE SAME

the specification of which

_____ is attached hereto.

X was filed on April 27, 1999 as International Application Serial No. PCT/JP99/02243,
with amendment(s) through _____ (if applicable, give dates).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Sec. 1.56.

I hereby claim foreign priority benefits under Title 35, United States Code, § 119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)	[list additional applications on separate page]:	Priority Claimed:		
Number:	Country:	Filed (Day/Month/Year):	Yes	No
P10-117537	Japan	April 27, 1998	X	
PCT/JP99/02243	PCT	April 27, 1999	X	

I hereby claim the benefit under Title 35, United States Code, § 120 of any United States application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States application in the manner provided by the first paragraph of Title 35, United States Code § 112, I acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me to be material to patentability as defined in Title 37, Code of Federal Regulations, Sec. 1.56, which became available between the filing date of the prior application and the national or PCT international filing date of this application:

Prior U.S. Application(s) [list additional applications on separate page]:

Appln. Ser. Number: _____ Filed (Day/Month/Year): _____ Status (patented, pending, abandoned): _____

I hereby appoint WILLIAM S. FROMMER, Registration No. 25,506, and DENNIS M. SMID, Registration No. 34,930 or their duly appointed associate, my attorneys, with full power of substitution and revocation, to prosecute this application, to make alterations and amendments therein, to file continuation and divisional applications thereof, to receive the Patent, and to transact all business in the Patent and Trademark Office and in the Courts in connection therewith, and specify that all communications about the application are to be directed to the following correspondence address:

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to the attention of:
WILLIAM S. FROMMER

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Date: _____

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Note: In order to qualify for reduced fees available to Small Entities, each inventor and any other individual or entity having rights to the invention must also sign an appropriate separate "Verified Statement (Declaration) Claiming [or Supporting a Claim by Another for] Small Entity Status" form [e.g. for Independent Inventor, Small Business Concern, Nonprofit Organization, individual Non-Inventor].

Note: A post office address must be provided for each inventor.